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(54) **ADAPTIVE VIDEO QUALITY SUBSTITUTION**

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(51) **Int. Cl.**

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H04N 21/238	(2011.01)
H04N 21/24	(2011.01)
H04N 21/254	(2011.01)
H04N 21/258	(2011.01)

(52) **U.S. Cl.**

CPC ***H04N 21/2541*** (2013.01); ***H04N 21/23805*** (2013.01); ***H04N 21/2402*** (2013.01); ***H04N 21/25808*** (2013.01)

USPC **725/1**; 725/31; 725/32; 725/34; 725/64; 725/91; 725/104

(58) **Field of Classification Search**

USPC 725/1, 31, 32, 34, 64, 91, 104

See application file for complete search history.

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(57) **ABSTRACT**

A computing device, in a video content delivery network, intercepts requested video content prior to delivery of the requested video content to a customer premise device of the network, and receives subscription and authentication information of a customer associated with the customer premise device. The computing device receives video content provider information, and validates the requested video content based on the subscription and authentication information and the video content provider information. The computing device receives capability information associated with the customer premise device, and receives bandwidth information associated with the network. The computing device determines a quality of video content, to provide to the customer premise device, based on the customer premise device capability information and the network bandwidth information, and provides, to the customer premise device, video content with the determined quality.

25 Claims, 8 Drawing Sheets

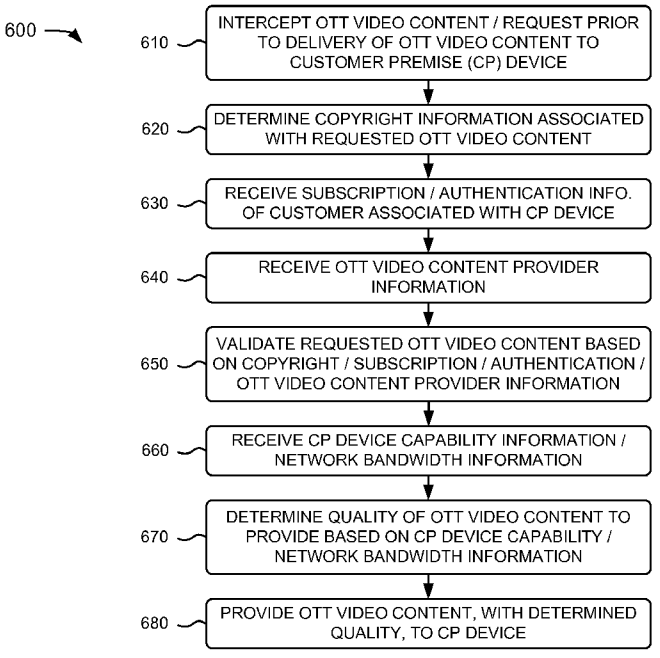


FIG. 1

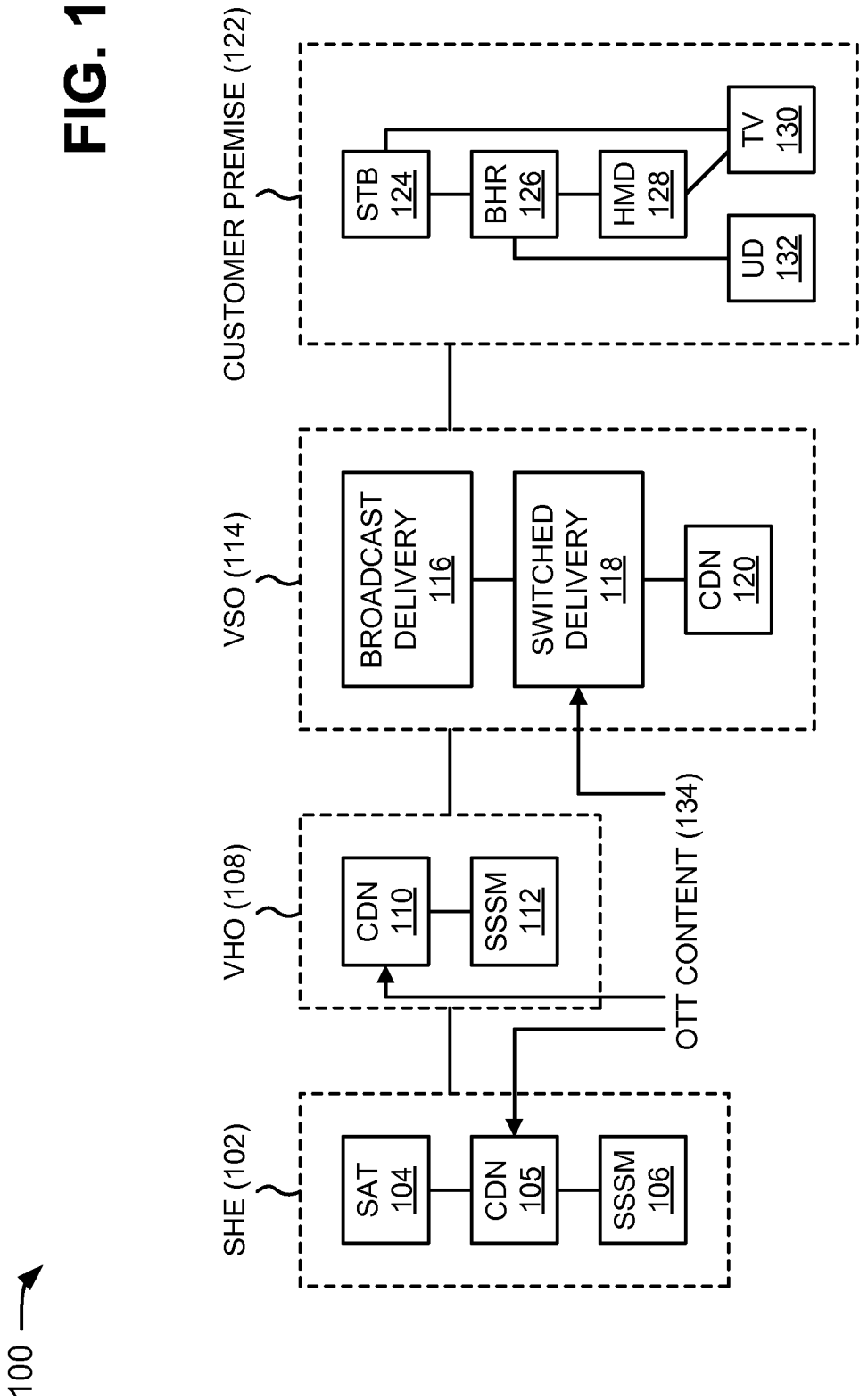

100
SHE (102)
SAT 104
CDN 105
SSSM 106
VHO (108)
CDN 110
SSSM 112
VSO (114)
BROADCAST DELIVERY 116
SWITCHED DELIVERY 118
CDN 120
CUSTOMER PREMISE (122)
STB 124
BHR 126
HMD 128
TV 130
UD 132
OTT CONTENT (134)

FIG. 2

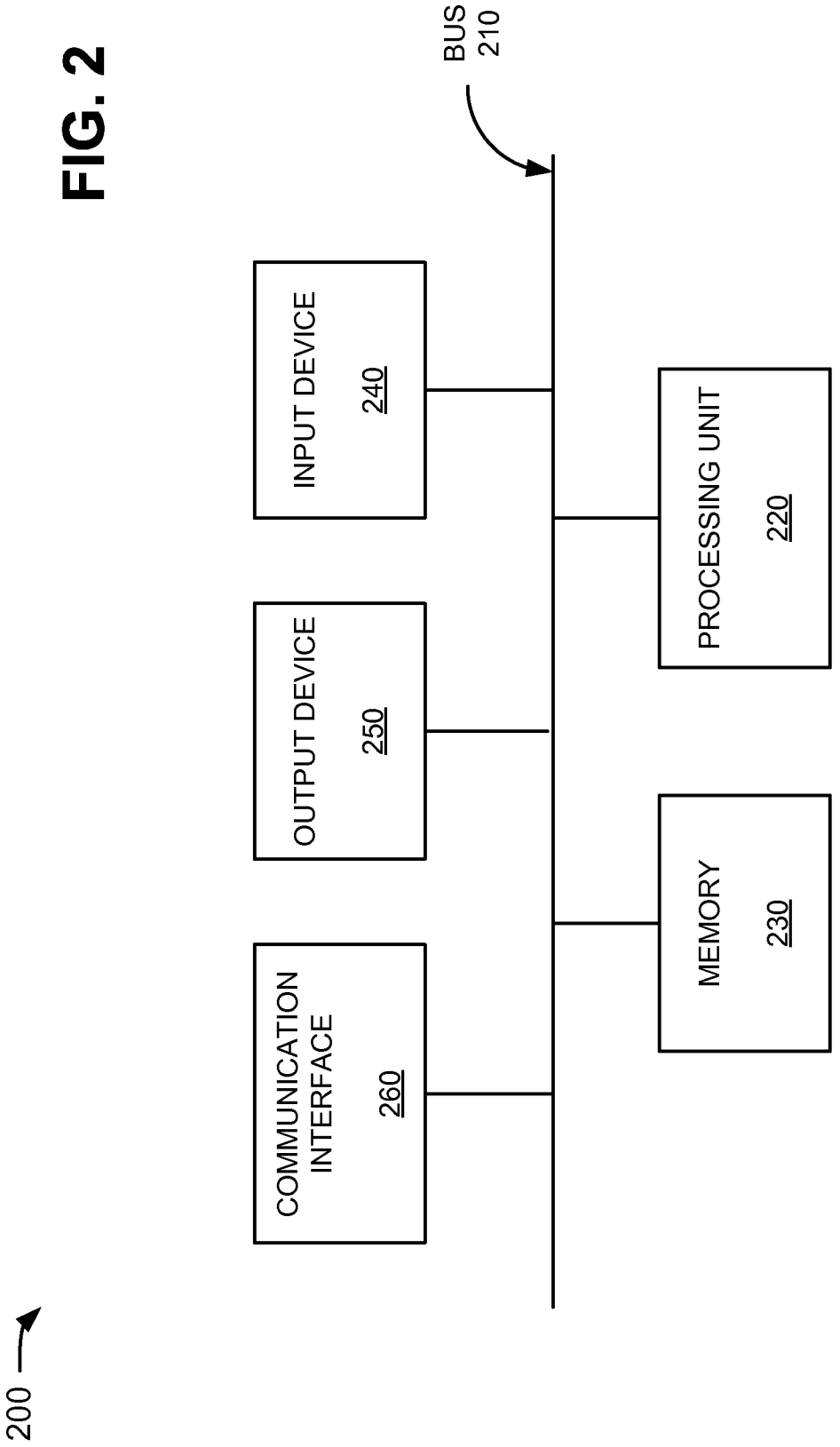

200
BUS
210
INPUT DEVICE
240
OUTPUT DEVICE
250
COMMUNICATION INTERFACE
260
PROCESSING UNIT
220
MEMORY
230

FIG. 3

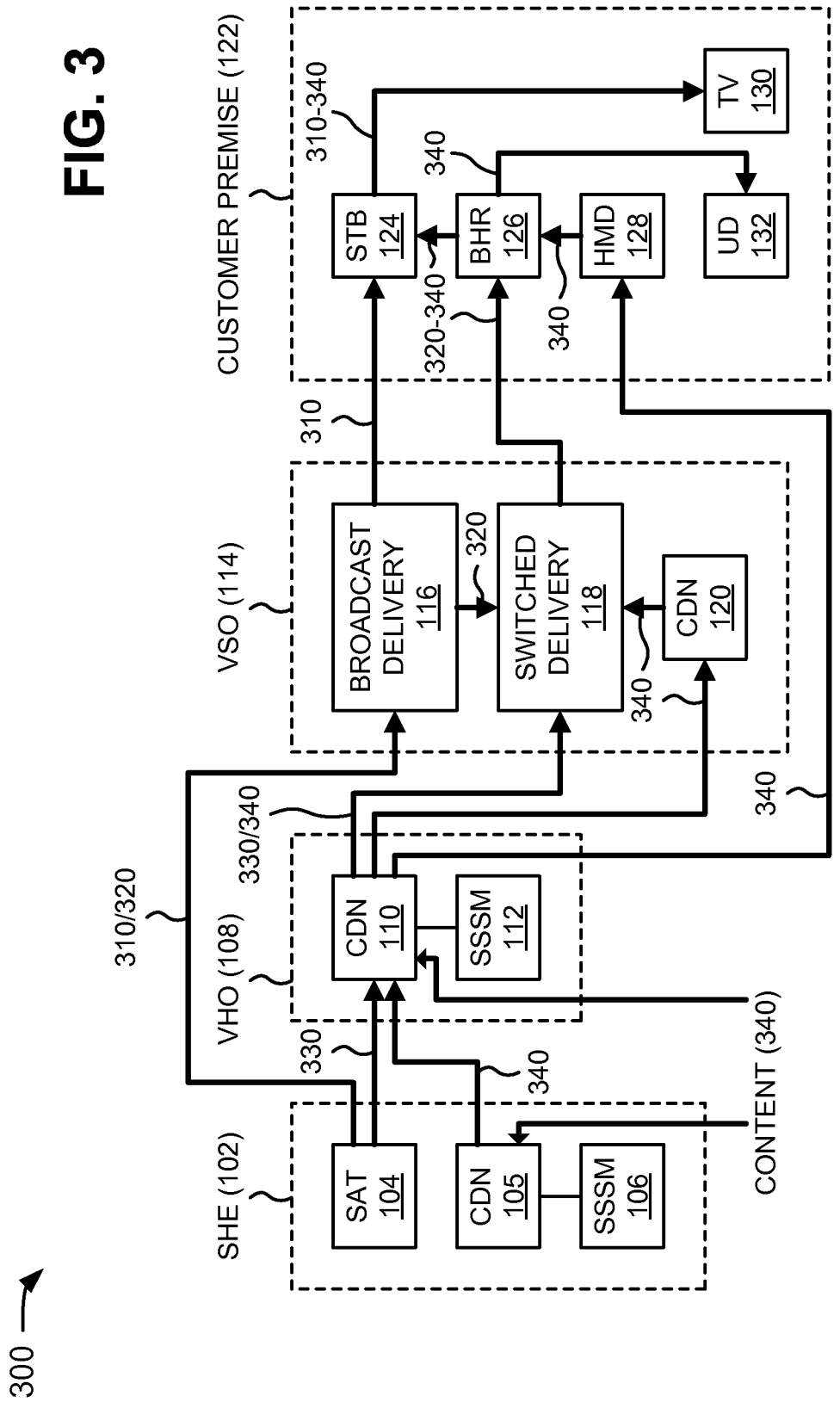

300
SHE (102)
SAT 104
CDN 105
SSM 106
VHO (108)
CDN 110
SSM 112
VSO (114)
BROADCAST DELIVERY 116
SWITCHED DELIVERY 118
CDN 120
CUSTOMER PREMISE (122)
STB 124
BHR 126
HMD 128
TV 130
UD 132
CONTENT (340)
310/320
330/340
310
320
330
340
310-340
320-340

FIG. 4

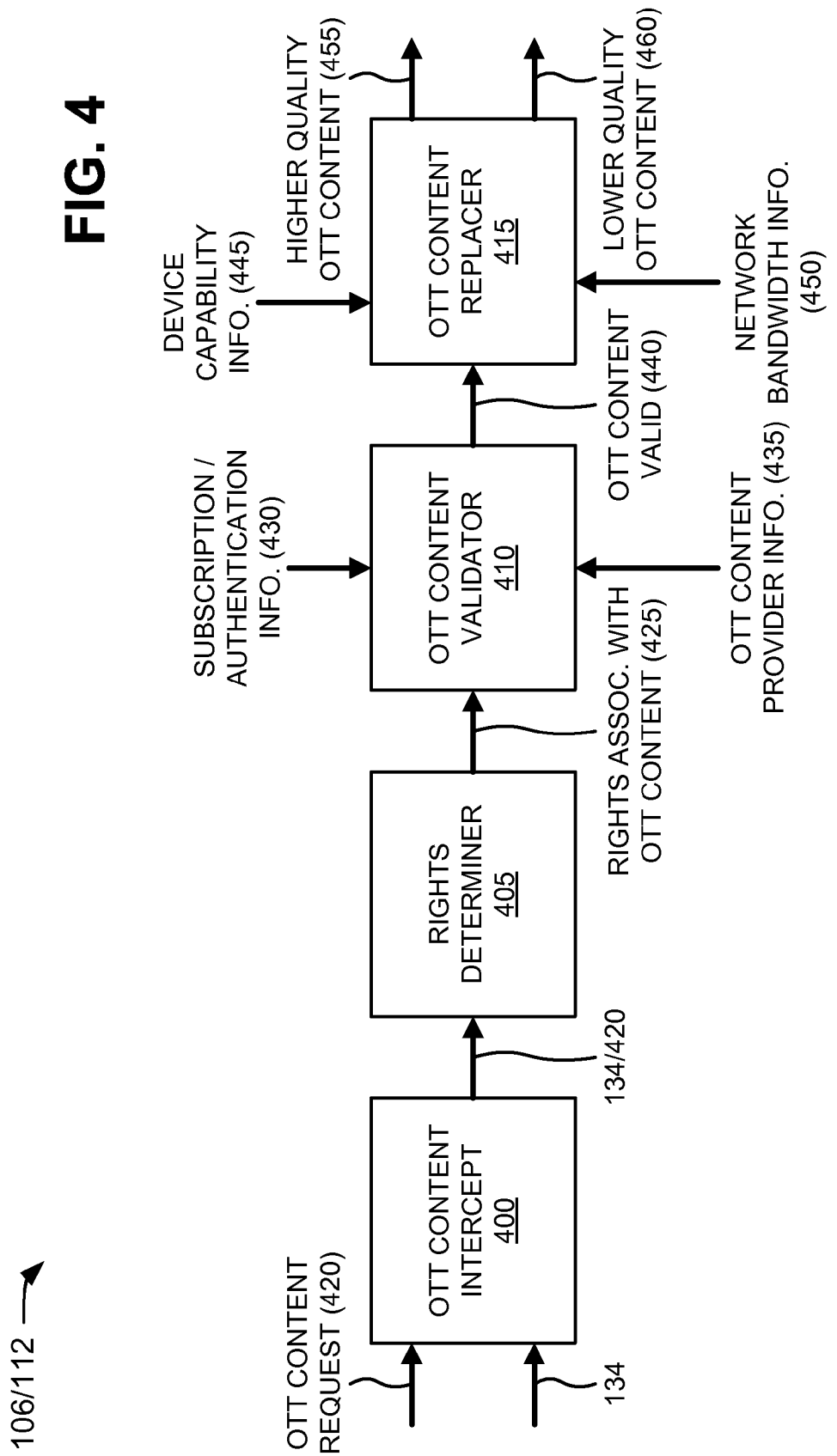

106/112
OTT CONTENT REQUEST (420)
134
OTT CONTENT INTERCEPT 400
134/420
RIGHTS DETERMINER 405
RIGHTS ASSOC. WITH OTT CONTENT (425)
SUBSCRIPTION / AUTHENTICATION INFO. (430)
OTT CONTENT VALIDATOR 410
OTT CONTENT VALID (440)
OTT CONTENT PROVIDER INFO. (435)
DEVICE CAPABILITY INFO. (445)
OTT CONTENT REPLACER 415
HIGHER QUALITY OTT CONTENT (455)
NETWORK BANDWIDTH INFO. (450)
LOWER QUALITY OTT CONTENT (460)

FIG. 5

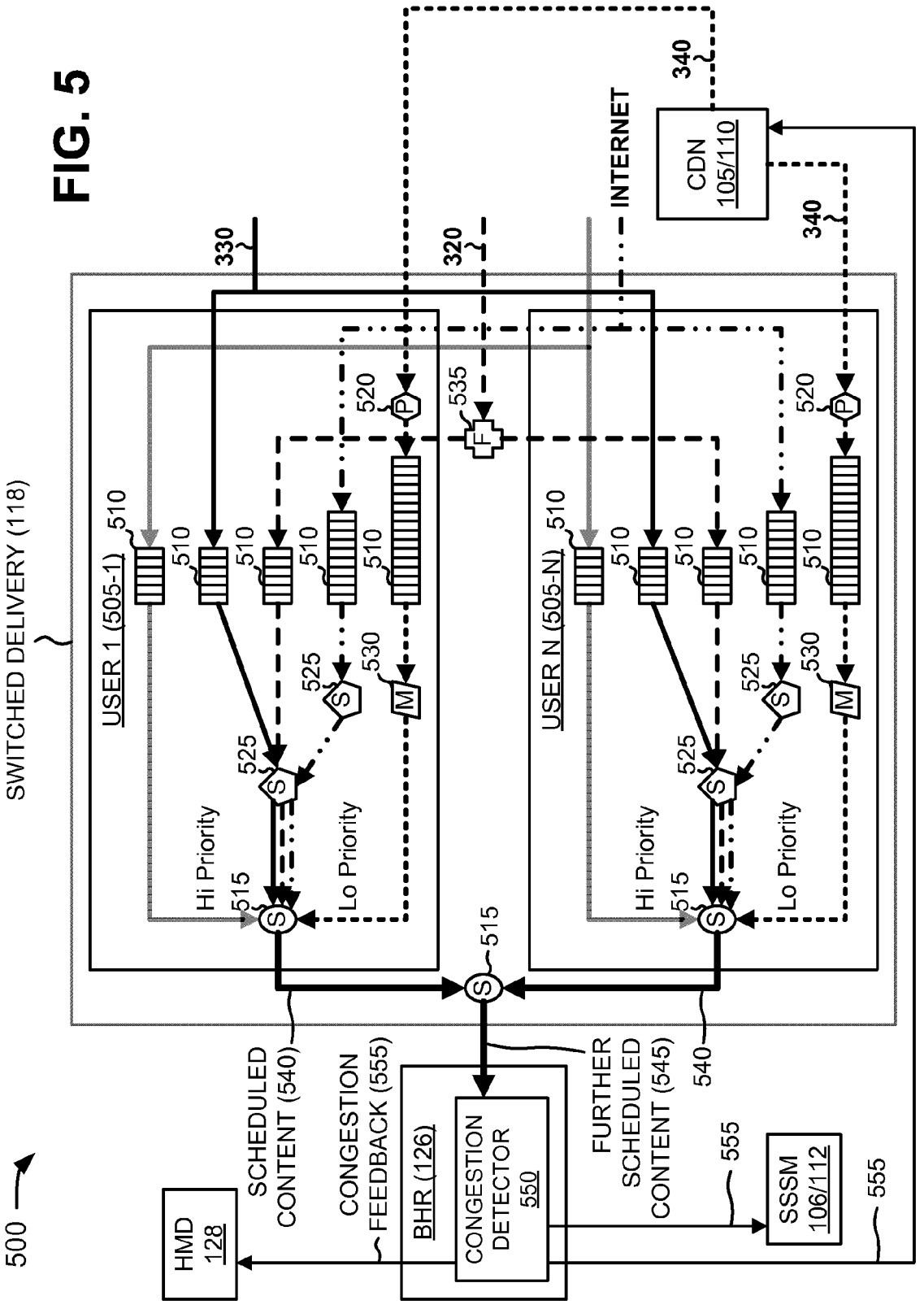

500
SWITCHED DELIVERY (118)
USER 1 (505-1)
USER N (505-N)
510
515
520
525
530
535
Hi Priority
Lo Priority
330
320
340
INTERNET
CDN 105/110
SCHEDULED CONTENT (540)
CONGESTION FEEDBACK (555)
FURTHER SCHEDULED CONTENT (545)
540
555
HMD 128
BHR (126)
CONGESTION DETECTOR 550
SSSM 106/112

FIG. 6

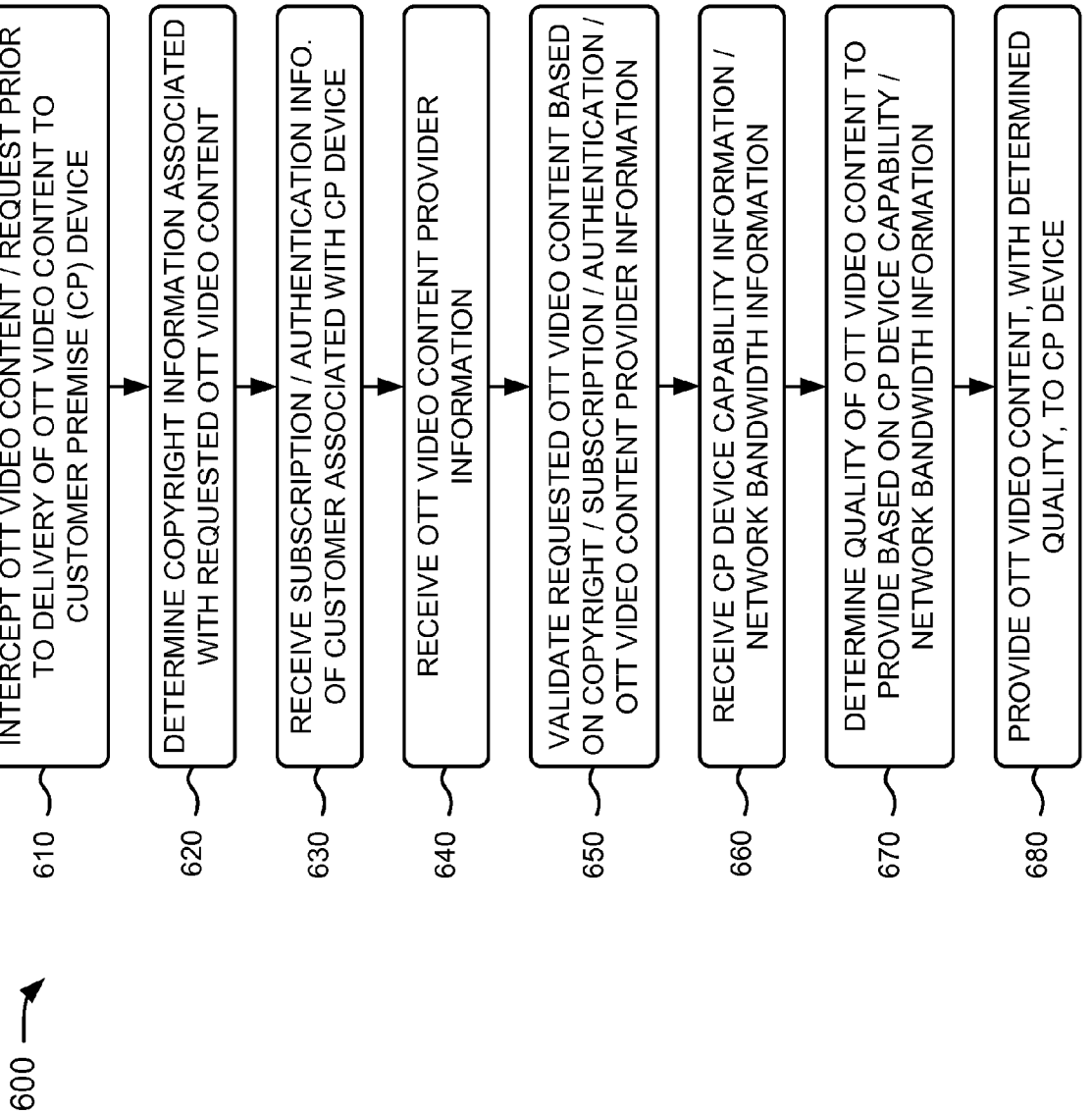

600
610
INTERCEPT OTT VIDEO CONTENT / REQUEST PRIOR TO DELIVERY OF OTT VIDEO CONTENT TO CUSTOMER PREMISE (CP) DEVICE
620
DETERMINE COPYRIGHT INFORMATION ASSOCIATED WITH REQUESTED OTT VIDEO CONTENT
630
RECEIVE SUBSCRIPTION / AUTHENTICATION INFO. OF CUSTOMER ASSOCIATED WITH CP DEVICE
640
RECEIVE OTT VIDEO CONTENT PROVIDER INFORMATION
650
VALIDATE REQUESTED OTT VIDEO CONTENT BASED ON COPYRIGHT / SUBSCRIPTION / AUTHENTICATION / OTT VIDEO CONTENT PROVIDER INFORMATION
660
RECEIVE CP DEVICE CAPABILITY INFORMATION / NETWORK BANDWIDTH INFORMATION
670
DETERMINE QUALITY OF OTT VIDEO CONTENT TO PROVIDE BASED ON CP DEVICE CAPABILITY / NETWORK BANDWIDTH INFORMATION
680
PROVIDE OTT VIDEO CONTENT, WITH DETERMINED QUALITY, TO CP DEVICE

FIG. 7

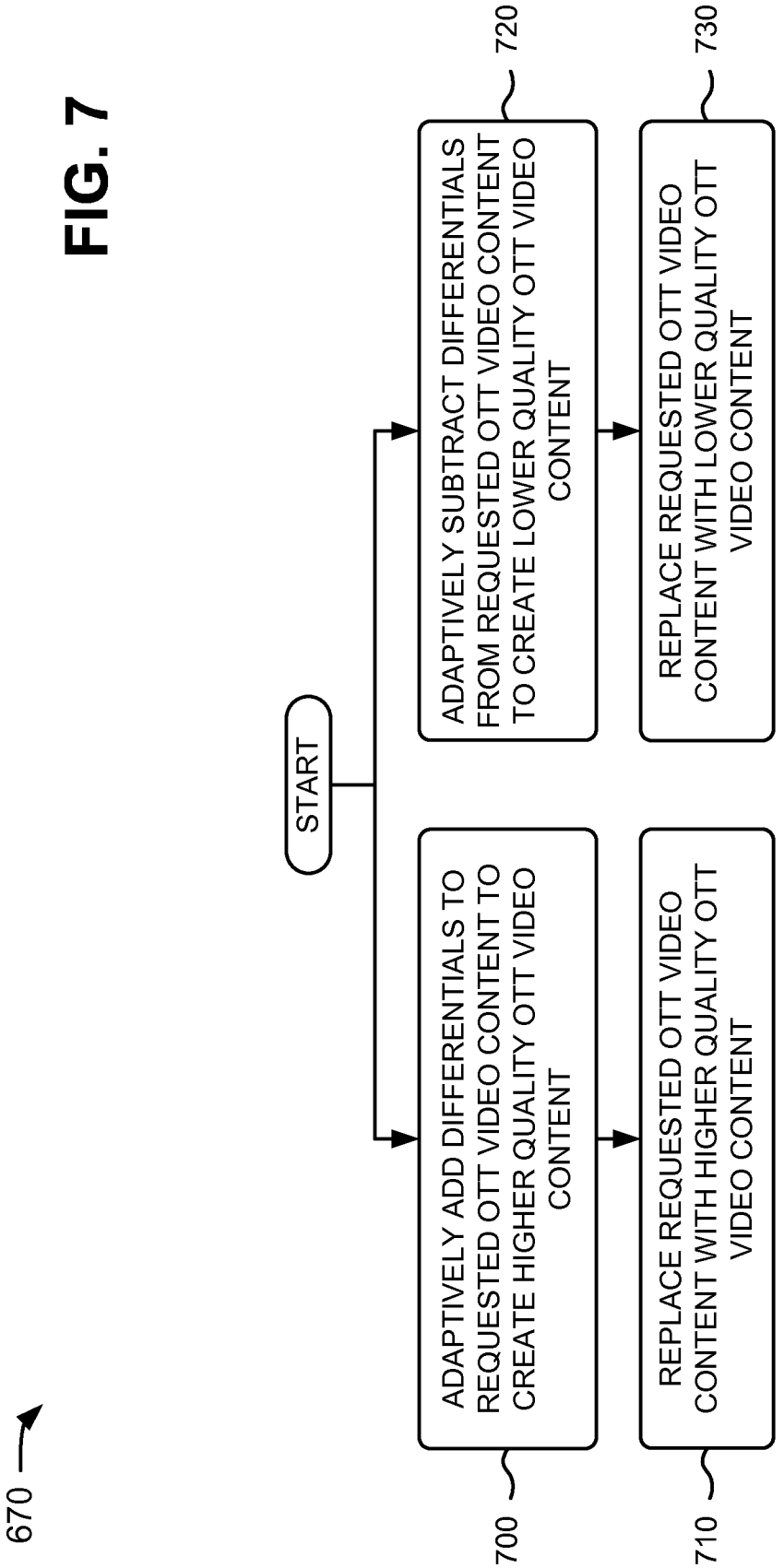
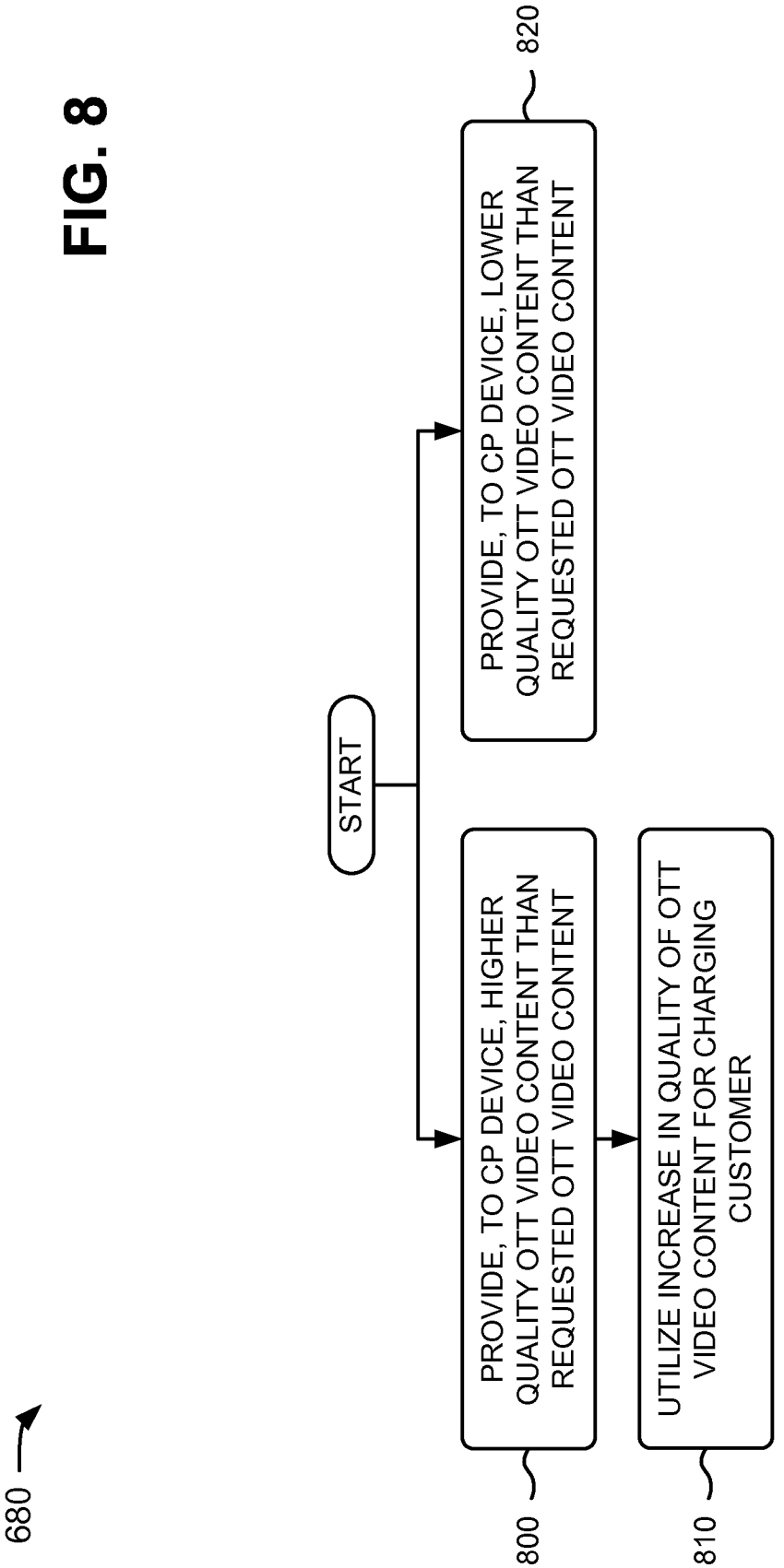

670
START
ADAPTIVELY ADD DIFFERENTIALS TO REQUESTED OTT VIDEO CONTENT TO CREATE HIGHER QUALITY OTT VIDEO CONTENT
700
REPLACE REQUESTED OTT VIDEO CONTENT WITH HIGHER QUALITY OTT VIDEO CONTENT
710
ADAPTIVELY SUBTRACT DIFFERENTIALS FROM REQUESTED OTT VIDEO CONTENT TO CREATE LOWER QUALITY OTT VIDEO CONTENT
720
REPLACE REQUESTED OTT VIDEO CONTENT WITH LOWER QUALITY OTT VIDEO CONTENT
730

FIG. 8


680
START
PROVIDE, TO CP DEVICE, HIGHER QUALITY OTT VIDEO CONTENT THAN REQUESTED OTT VIDEO CONTENT
800
UTILIZE INCREASE IN QUALITY OF OTT VIDEO CONTENT FOR CHARGING CUSTOMER
810
PROVIDE, TO CP DEVICE, LOWER QUALITY OTT VIDEO CONTENT THAN REQUESTED OTT VIDEO CONTENT
820

ADAPTIVE VIDEO QUALITY SUBSTITUTION

BACKGROUND

Video content (e.g., television shows, pay-per-view (PPV) content, video-on-demand (VOD) content, etc.) may be delivered and selected in several ways. For example, television channels may be broadcast to subscribers' homes and a channel may be viewed via subscriber selection from a channel lineup. Time shifted Internet protocol (IP) television (IPTV) emulates this broadcast delivery over IP, which overcomes bottlenecks associated with lower speed access networks (e.g., twisted pair, digital subscriber line (DSL), wireless, etc. networks) by sending content during time periods when there is spare capacity, or sending content at a rate slower than the playback rate as constrained by an access network bandwidth.

However, IPTV provides a large number of channels that make user selection difficult. Digital video recorders (DVRs) may be used to record video content so that the video content may be viewed at a later time. DVR-based recording, however, is largely limited to tuning to a particular channel (e.g., from a channel lineup), and selecting a time period for recording the particular channel.

Over the top (OTT), or IP unicast, delivery of video content may provide video content to any connected device (e.g., televisions, computers, gaming consoles, smart phones, etc.). OTT video content may include, for example, pre-recorded video content (e.g., television episodes), and content associated with video portals provided by content providers, such as Hulu™, YouTube™, CNN, etc. OTT delivery provides near real time transmission (e.g., with an adaptive transmission rate) of video content, with limited buffering. Furthermore, video content requests are directed to content servers in order to optimize criteria or meet constraints associated with the video content requests. The content servers may optimize the requests' criteria or meet constraints based on performance (e.g., latency), minimum topology hops, historical server load (e.g., sessions, throughput, etc.), economic cost, etc. Content delivery networks (CDNs) may use a variety of mechanisms to determine optimality and/or constraints associated with video content requests. For example, CDNs may configure and transfer address assignments into CDN trackers; may configure domain name system (DNS) redirection; may use load balancers to distribute traffic between servers in a site or between sites; may use quasi-static application layer traffic optimization and pay for performance (P4P) approaches to provide feedback; and may use heuristic algorithms.

However, OTT delivery of video content over a routed network can make use of only limited topology and load information and must convey the content at the playback rate in near real time and only at the requested rate and quality. Furthermore, OTT delivery requires manual (or operations support systems (OSS) application-based) configuration of consistent information in multiple servers. Thus, true optimization is difficult to achieve in OTT delivery of video content and OTT delivery may create network congestion and/or additional operator expense to provision the network for peak load.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of an example network in which systems and/or methods described herein may be implemented;

FIG. **2** is a diagram of example components of one or more of the devices of the network depicted in FIG. **1**;

FIG. **3** is a diagram of example interactions between components of an example portion of the network depicted in FIG. **1**;

FIG. **4** is a diagram of example functional components of a subscription, search, and selection management (SSSM) server of the network depicted in FIG. **1**;

FIG. **5** is a diagram of example functional components of a switched delivery system of the network depicted in FIG. **1**; and

FIGS. **6-8** are flow charts of an example process for providing adaptive video quality substitution according to implementations described herein.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The following detailed description refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements. Also, the following detailed description does not limit the invention.

Systems and/or methods described herein may provide adaptive video quality substitution for video content. The adaptive video quality substitution may match a quality of the delivered video content to the capabilities of a device receiving the video content and/or based on network bandwidth available for delivering the video content. In one example, the systems and/or methods may apply adaptive video quality substitution to OTT video content. In other examples, the systems and/or methods may apply adaptive video quality substitution to video content other than OTT video content.

In one example implementation, the systems and/or methods may be implemented in a network that delivers video content. The systems and/or methods may intercept OTT video content (or a request for OTT video content) prior to delivery of the OTT video content to a customer premise device of the network, and may determine copyright information associated with the requested OTT video content. The systems and/or methods may receive subscription and/or authentication information of a customer associated with the customer premise device, and may receive OTT video content provider information. The systems and/or methods may validate the requested OTT video content based on the copyright information, the subscription/authentication information, and/or the OTT video content provider information, and may receive customer premise device capability information and/or network bandwidth information. The systems and/or methods may determine a quality of OTT video content to provide based on the customer premise device capability information and/or the network bandwidth information, and may provide the OTT video content, with the determined quality, to the customer premise device.

As used herein, the terms "subscriber," "customer,' and/or "user" may be used interchangeably. Also, the terms "subscriber," "customer," and/or "user" are intended to be broadly interpreted to include a user device (e.g., a mobile telephone, a personal computer, a set-top box, a television, etc.) or a user of a user device.

FIG. **1** is a diagram of an example network **100** in which systems and/or methods described herein may be implemented. As illustrated, network **100** may include a super head end (SHE) **102** that includes a satellite dish (SAT) **104**, content delivery network (CDN) storage **105**, and a subscription/selection/search management (SSSM) server **106**; a video hub office (VHO) **108** that includes CDN storage **110** and a SSSM server **112**; a video serving office (VSO) **114** that includes a broadcast delivery system **116**, a switched delivery system **118**, and CDN storage **120**; a customer premise **122**

that includes a STB **124**, a broadband home router (BHR) **126**, a home media device (HMD) **128**, a television (TV) **130**, and a user device (UD) **132**.

Components of network **100** may interconnect via wired and/or wireless connections. The lines shown between components of network **100** represent example connections. However, components of network **100** may connect to one or more other components of network **100** even if a line showing a connection is not depicted in FIG. **1**. Single components and/or networks have been illustrated in FIG. **1** for simplicity. In practice, there may be more components and/or networks than depicted in FIG. **1**.

SHE **102** may include one or more server devices (e.g., a top level of CDN or cache hierarchy), or other types of computation or communication devices, that gather, process, search, and/or provide information in a manner described herein. In one implementation, SHE **102** may include a computer system, applications, a cable head-end, and/or broadcasting devices capable of providing video content (e.g., VOD content, high definition (HD)-VOD content, TV programming, movies, on-demand services, live television, IPTV, etc.), commercials, advertisements, instructions, voice content (e.g., voice over IP (VoIP)), and/or other information to customer premises equipment (CPE). In one example, SHE **102** may include a television media reception, processing, and distribution system that selects, combines, and transmits the video content (e.g., VOD, IPTV, etc.) to other headend distribution systems.

Satellite dish **104** may include a parabolic antenna (or other types of antennas) designed to receive microwaves from communications satellites, which transmit data transmissions or broadcasts, such as satellite television, VOD content, etc.

CDN storage **105** may include a random access memory (RAM) or another type of dynamic storage device that stores information and instructions, a read only memory (ROM) or another type of static storage device that stores static information and instructions, and/or some other type of magnetic or optical recording medium and its corresponding drive for storing information and/or instructions. In one example implementation, CDN storage **105** may receive non-real time video content (e.g., OTT video content, pre-recorded video content, previous episodes, media-oriented advertisements, etc.), and may provide the non-real time video content to CDN storage **110**.

SSSM server **106** may include one or more server devices, or other types of computation or communication devices, that gather, process, search, and/or provide information in a manner described herein. In one implementation, SSSM server **106** may include one or more server devices that enable the scheduling and coordinating of under-the-bottom time-shifted distribution of non-real time video content (e.g., OTT video content, pre-recorded video content, previous episodes, media-oriented advertisements, etc.) during idle time periods of network **100** (e.g., at night, during low traffic, etc.). In one example, SSSM server **106** may instruct CDN storage **105** to provide such non-real time video content to CDN storage **110**, and SSSM server **112** may instruct CDN storage **110** to forward the non-real time video content to switched delivery system **118**, CDN storage **120**, and/or HMD **128**. The non-real time video content may be provided "under-the-bottom" of network **100** since the content is provided when network **100** is not experiencing congestion. In contrast, and as described above, OTT delivery of video content may create network congestion.

VHO **108** may include one or more server devices, or other types of computation or communication devices, that gather, process, search, and/or provide information in a manner described herein. In one implementation, VHO **108** may include a computer system, applications, and/or broadcasting devices capable of providing video content to a regional location. A regional VHO **108** may serve a local VSO (e.g., VSO **114**), and the local VSO may provide the video content to customer premises equipment.

CDN storage **110** may include a RAM or another type of dynamic storage device that stores information and instructions, a ROM or another type of static storage device that stores static information and instructions, and/or some other type of magnetic or optical recording medium and its corresponding drive for storing information and/or instructions. In one example implementation, CDN storage **110** may receive VOD content from satellite dish **104**, and may provide the VOD content to broadcast delivery system **116** and/or switched delivery system **118**. In another example implementation, CDN storage **110** may receive non-real time video content from CDN storage **105**, and may provide the non-real time video content to switched delivery system **118**, CDN storage **120**, and/or HMD **128**.

SSSM server **112** may include one or more server devices, or other types of computation or communication devices, that gather, process, search, and/or provide information in a manner described herein. In one implementation, SSSM server **112** may include one or more server devices that provide under-the-bottom time-shifted distribution of non-real time video content during idle time periods of network **100**. In one example, SSSM server **112** may instruct CDN storage **110** to provide such non-real time video content to switched delivery system **118**, CDN storage **120**, and/or HMD **128**. The non-real time video content may be provided "under-the-bottom" of network **100** since the content is provided when network **100** is not experiencing congestion.

VSO **114** may include one or more server devices, or other types of computation or communication devices, that gather, process, search, and/or provide information in a manner described herein. In one implementation, VSO **114** may include a computer system, applications, and/or broadcasting devices capable of receiving video content from a regional VHO (e.g., VHO **108**), and providing the video content to customer premises equipment (e.g., to STB **124**, BHR **126**, etc.).

Broadcast delivery system **116** may include one or more server devices, or other types of computation or communication devices, that gather, process, search, and/or provide information in a manner described herein. In one implementation, broadcast delivery system **116** may include a computer system, applications, and/or broadcasting devices capable of receiving broadcast television content from satellite dish **104**, and providing the broadcast television content to STB **124**. Broadcast delivery system **116** may also provide IPTV content (e.g., received from satellite dish **104**) to switched delivery system **118**, and switched delivery system **118** may provide the IPTV content to BHR **126**.

Switched delivery system **118** may include one or more server devices, or other types of computation or communication devices, that gather, process, search, and/or provide information in a manner described herein. In one implementation, switched delivery system **118** may include a network of devices capable of receiving VOD content and non-real time video content from CDN storage **110**, receiving IPTV content from broadcast delivery system **116**, and receiving non-real time video content from CDN storage **120**. Switched delivery system **118** may provide the VOD content, the IPTV content, and/or the non-real time video content to BHR **126**. Switched delivery system **118** may provide unicast or multicast content. Multicast content may require scheduling by

SSSM servers **106/112** to optimize delivery of content to a large number of HMDs **128** (e.g., selecting and subscribing to popular content). Any portions of content dropped during multicast transmission (e.g., due to bit errors or packet loss) can be resent via unicast transmission. Furthermore, if some HMDs **128** are off line (e.g., due to a power or network outage), such HMDs **128** may "caught up" via unicast transmission.

CDN storage **120** may include a RAM or another type of dynamic storage device that stores information and instructions, a ROM or another type of static storage device that stores static information and instructions, and/or some other type of magnetic or optical recording medium and its corresponding drive for storing information and/or instructions. In one example implementation, CDN storage **120** may store non-real time video content received from CDN storage **110**, and may provide the non-real time video content to switched delivery system **118**.

Customer premise **122** may include a subscriber's premises (e.g., a home) and the associated equipment connected with a service provider (e.g., a carrier's telecommunication equipment).

STB **124** may include a device that receives and/or processes video content, and provides the video content to television **130** or another device. STB **124** may also include decoding and/or decryption capabilities and may further include a digital video recorder (DVR) (e.g., a hard drive). In one example implementation, STB **124** may be incorporated directly within television **130**. In another implementation, STB **124** and/or television **130** may be replaced with a computing device (e.g., a personal computer, a laptop computer, a tablet computer, etc.), a cable card, a TV tuner card, or a portable communication device (e.g., a mobile telephone or a PDA). In one example, STB **124** may receive video content (e.g., broadcast television content, IPTV content, VOD content, etc.) from broadcast delivery system **116** and/or BHR **126**, and may provide the video content to television **130** for display.

BHR **126** may include one or more data processing and/or data transfer devices, such as a gateway, a router, a modem, a switch, a firewall, a network interface card (NIC), a hub, a bridge, a proxy server, an optical add-drop multiplexer (OADM), or some other type of device that processes and/or transfers data. In one example, BHR **126** may be physically deployed with a satellite antenna (e.g., on a roof or a side wall of a house associated with customer premise **122**). BHR **126** may support sharing of cable modem or Internet connections, and may include various network security features like firewall capability. In one example, BHR **126** may receive video content (e.g., IPTV content or VOD content) from switched delivery system **118**, and may provide the video content to STB **124**. In another example, BHR **126** may receive real time and/or non-real time video content from switched delivery system **118** and/or HMD **128**, and may provide the real time and/or non-real time video content to television **130** and/or to user device **132**.

HMD **128** may include a RAM or another type of dynamic storage device that stores information and instructions, a ROM or another type of static storage device that stores static information and instructions, and/or some other type of magnetic or optical recording medium and its corresponding drive for storing information and/or instructions. In one example implementation, HMD **128** may provide storage for non-real time video content (e.g., received from CDN storage **110** during idle time periods or network **100**), and may provide the non-real time video content to BHR **126** when user device **132** requests the non-real time video content.

Television **130** may include a television monitor that is capable of displaying video content, television programming, content provided by STB **124**, and/or content provided by other devices (e.g., a digital video disk (DVD) player, a video camera, etc., not shown) connected to television **130**.

User device **132** may include any device that is capable of communicating with BHR **126** (e.g., to reach other functions in network **100**, such as SSSM servers **106/112**) in order to, for example, request and/or receive video content. For example, user device **110** may include a mobile computation and/or communication device, such as a radiotelephone, a personal communications system (PCS) terminal (e.g., that may combine a cellular radiotelephone with data processing and data communications capabilities), a personal digital assistant (PDA) (e.g., that can include a radiotelephone, a pager, Internet/intranet access, etc.), a wireless device, a smart phone, a laptop computer (e.g., with a wireless air card), a global positioning system (GPS) device, a content recording device (e.g., a camera, a video camera, etc.), etc. In another example, user device **110** may include a fixed (e.g., provided in a particular location, such as within a customer's home) computation and/or communication device, such as a laptop computer, a personal computer, a tablet computer, a television, a gaming system, etc.

As further shown in FIG. **1**, OTT content **134** may be provided to CDN storage **105** (e.g., which may be controlled by SSSM server **106**), CDN storage **110** (e.g., which may be controlled by SSSM server **112**), and/or switched delivery system **118**. OTT content **134** may include, for example, pre-recorded video content (e.g., television episodes); content associated with video portals provided by content providers, such as Hulu™, YouTube, CNN, etc.; video content delivered over an alternative means (e.g., the Internet) rather than a main video delivery infrastructure (e.g., a cable television infrastructure); etc.

Although FIG. **1** shows example components of network **100**, in other implementations, network **100** may include fewer components, different components, differently arranged components, and/or additional components than those depicted in FIG. **1**. Alternatively, or additionally, one or more components of network **100** may perform one or more other tasks described as being performed by one or more other components of network **100**.

FIG. **2** is a diagram of example components of a device **200** that may correspond to one of the devices of network **100**. As illustrated, device **200** may include a bus **210**, a processing unit **220**, a memory **230**, an input device **240**, an output device **250**, and a communication interface **260**.

Bus **210** may permit communication among the components of device **200**. Processing unit **220** may include one or more processors or microprocessors that interpret and execute instructions. In other implementations, processing unit **220** may be implemented as or include one or more application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), or the like.

Memory **230** may include a RAM or another type of dynamic storage device that stores information and instructions for execution by processing unit **220**, a ROM or another type of static storage device that stores static information and instructions for the processing unit **220**, and/or some other type of magnetic or optical recording medium and its corresponding drive for storing information and/or instructions.

Input device **240** may include a device that permits an operator to input information to device **200**, such as a keyboard, a keypad, a mouse, a pen, a microphone, one or more

biometric mechanisms, and the like. Output device **250** may include a device that outputs information to the operator, such as a display, a speaker, etc.

Communication interface **260** may include any transceiver-like mechanism that enables device **200** to communicate with other devices and/or systems. For example, communication interface **360** may include mechanisms for communicating with other devices, such as other devices of network **100**.

As described herein, device **200** may perform certain operations in response to processing unit **220** executing software instructions contained in a computer-readable medium, such as memory **230**. A computer-readable medium may be defined as a physical or logical memory device. A logical memory device may include memory space within a single physical memory device or spread across multiple physical memory devices. The software instructions may be read into memory **230** from another computer-readable medium or from another device via communication interface **260**. The software instructions contained in memory **230** may cause processing unit **220** to perform processes described herein. Alternatively, hardwired circuitry may be used in place of or in combination with software instructions to implement processes described herein. Thus, implementations described herein are not limited to any specific combination of hardware circuitry and software.

Although FIG. **2** shows example components of device **200**, in other implementations, device **200** may include fewer components, different components, differently arranged components, or additional components than depicted in FIG. **2**. Alternatively, or additionally, one or more components of device **200** may perform one or more other tasks described as being performed by one or more other components of device **200**.

FIG. **3** is a diagram of example interactions between components of an example portion **300** of network **100**. As illustrated, example network portion **300** may include SHE **102**, satellite dish **104**, CDN storage **105**, SSSM server **106**, VHO **108**, CDN storage **110**, SSSM server **112**, VSO **114**, broadcast delivery system **116**, switched delivery system **118**, CDN storage **120**, customer premise **122**, STB **124**, BHR **126**, HMD **128**, television (TV) **130**, and user device (UD) **132**. In one implementation, the components depicted in network portion **300** may include the features described above in connection with one or more of FIGS. **1** and **2**.

As further shown in FIG. **3**, satellite dish **104** may receive video content **310** (e.g., via reception of satellite transmissions), and may provide video content **310** to broadcast delivery system **116**. In one example, video content **310** may include content adhering to quadrature amplitude modulation (QAM) broadcast standards, such as broadcast television. Broadcast delivery system **116** may provide video content **310** to STB **124**, and STB **124** may provide video content **310** to television **130**. Television **130** may receive video content **310** and may display video content **310** (e.g., to a user).

Satellite dish **104** may receive video content **320** (e.g., via reception of satellite transmissions), and may provide video content **320** to broadcast delivery system **116**. In one example, video content **320** may include real time (RT) multicast video content, such as broadcast long-tail IPTV content. Broadcast delivery system **116** may provide video content **320** to switched delivery system **118**, switched delivery system **118** may provide video content **320** to BHR **126**, and BHR **126** may provide video content **320** to STB **124**. STB **124** may provide video content **320** to television **130**, and television **130** may display video content **320** (e.g., to a user).

Satellite dish **104** may receive video content **330** (e.g., via reception of satellite transmissions), and may provide video content **330** to CDN storage **110**. In one example, video content **330** may include real time (RT) unicast video content, such as VOD content. CDN storage **110** may provide video content **330** to switched delivery system **118**, switched delivery system **118** may provide video content **330** to BHR **126**, and BHR **126** may provide video content **330** to STB **124**. STB **124** may provide video content **330** to television **130**, and television **130** may display video content **330** (e.g., to a user).

As further shown in FIG. **3**, video content **340** may be provided to CDN storage **105** and/or to CDN storage **110** (e.g., from content providers, not shown). In one example, video content **340** may include best effort (BE) (or higher priority) unicast video content (e.g., OTT content **134**), lower effort (LE) (or lower priority) multicast video content, and/or LE unicast video content. In one example implementation, video content **340** may include non-real time video content that is to be delivered during idle time periods of network **100**. SSSM server **106** may instruct CDN **105** to provide video content **340** to CDN storage **110**. SSSM server **112** may instruct CDN storage **110** to provide video content **340** to switch delivery system **118**, CDN storage **120**, and/or HMD **128**. CDN storage **120** may provide video content **340** to switched delivery system **118**. Switched delivery system **118** may provide video content **340** to BHR **126**, and BHR **126** may provide video content **340** to STB **124** and/or user device **132** (e.g., for display to a user). STB **124** may provide video content **340** to television **130**, and television **130** may display video content **330** (e.g., to a user). HMD **128** may store video content **340** for later retrieval by BHR **126**. BHR **126** may retrieve video content **340** from HMD **128**, and may provide video content **340** to STB **124**. STB **124** may provide video content **340** to television **130**, and television **130** may display video content **340** (e.g., to a user). HMD **128** may provide video content **340** to television **130** and/or user device **132** in real time and in a manner that provides security for video content **340**.

As described above, network portion **300** may utilize under-the-bottom lower effort (LE) IP transport for non-real time video content **340**, and may transmit non-real time video content **340** during idle time periods of network portion **300**. During the idle time periods, network portion **300** may have significant capacity available for provision (or transmission) of non-real time video content **340**. The non-real time video content **340** may be broadcast, in real time, at customer premise **122** (e.g., the next day). In one implementation, if network portion **300** detects network congestion (e.g., using a congestion notification), network portion **300** may reduce or cease provision (or transmission) of non-real time video content **340**.

The under-the-bottom delivery of non-real time video content **340** may make better use of existing resources in network portion **300**. In one example implementation, network portion **300** may charge for the amount of non-real time video content **340** that is transported (rather than how quickly it is transported), and may schedule delivery of non-real time video content **340** to maximize for off-peak network utilization and/or charges less for this (e.g., which may be important in lower bandwidth networks).

Although FIG. **3** shows example components of network portion **300**, in other implementations, network portion **300** may include fewer components, different components, differently arranged components, and/or additional components than depicted in FIG. **3**. Alternatively, or additionally, one or more components of network portion **300** may perform one or

more other tasks described as being performed by one or more other components of network portion **300**.

FIG. **4** is a diagram of example functional components of a SSSM server (e.g., SSSM server **106** or SSSM server **112**) of network **100**. In one implementation, the functions described in connection with FIG. **4** may be performed by one or more components of device **200** (FIG. **2**). As shown in FIG. **4**, SSSM servers **106/112** may include an OTT content intercept component **400**, a rights determiner **405**, an OTT content validator **410**, and an OTT content replacer **415**.

OTT content intercept component **400** may include hardware or a combination of hardware and software that may intercept OTT video content **134** (e.g., provided to SHE **102** or VHO **108**) or an OTT video content request **420** (e.g., provided to SHE **102** or VHO **108**). OTT video content request **420** may include a request for OTT content (e.g., video content **340**) that is generated by a customer premise device (e.g., STB **124**, television **130**, user device **132**, etc.). In one example, OTT video content request **420** may be provided from a customer premise device to CDN storage **105/110**. CDN storage **105/110** may provide OTT video content request **420** to SSSM server **106/112**, and may consult SSSM server **106/112** at the beginning of a content transfer to determine if a better quality version of content is available, authorized, and a customer is willing to pay for it. This is an example of a policy type interaction between CDN storage **105/110** and SSSM server **106/112**. In another example, OTT video content request **420** may include a request for a particular quality of OTT video content (e.g., higher quality OTT video content or lower quality OTT video content). SSSM server **106/112** may thus provide a controlled quality experience for OTT video content.

If OTT video content request **420** is received, OTT content intercept component **400** may also intercept the OTT video content requested by OTT video content request **420**. For example, this may be a policy request (i.e., a pull operation) from CDN storage **105/110** to SSSM server **106/112** or some other method (e.g., sniffing all content requests). As further shown in FIG. **4**, OTT content intercept component **400** may provide OTT video content **134** and/or request **420** to rights determiner component **405**.

Rights determiner **405** may include hardware or a combination of hardware and software that may receive OTT video content **134** and/or request **420** from OTT content intercept component **400**, and may determine rights associated with OTT video content **134** or the OTT video content requested by OTT video content request **420**, as indicated by reference number **425**. In one example implementation, OTT video content **134** may include copyright information (e.g., reproduction rights or download rights as set forth by the Digital Entertainment Content Ecosystem (DECE) consortium) that may be interpreted by rights determiner **405**. As further shown in FIG. **4**, rights determiner **405** may provide rights information **425** associated with OTT video content **134** to OTT content validator **410**.

OTT content validator **410** may include hardware or a combination of hardware and software that may receive rights information **425** from rights determiner **405**, and may receive subscription/authentication information **430** and/or OTT content provider information **435** (e.g., from one or more other components of network **100**). Subscription/authentication information **430** may include subscription information (e.g., premium subscription, price paid, third party charging supported for identified content, etc.) of a customer associated with a customer premise device (e.g., STB **124**, television **130**, user device **132**, etc.) requesting OTT video content **134**; authentication information (e.g., a customer name, a customer profile, a login name, a password, a secured subscriber device ID, or other authentication mechanisms) associated with the customer; etc. OTT content provider information **435** may include information (e.g., a name, price charged for content, etc.) associated with a provider of OTT video content **134**. OTT content validator **410** may validate OTT video content **134** based on rights information **425**, subscription/authentication information **430** and/or OTT content provider information **435**, and (e.g., if OTT video content **134** is valid) may provide an indication **440** that OTT video content **134** is valid to OTT content replacer **415**.

OTT content replacer **415** may include hardware or a combination of hardware and software that may receive indication **440** from OTT content validator **410**, and may receive device capability information **445** and/or network bandwidth information **450** (e.g., from one or more other components of network **100**). Device capability information **445** may include a capability (e.g., capable of receiving high quality video content, lower quality video content, etc.) of the customer premise device requesting OTT video content **134**. Network bandwidth information **450** may include bandwidth of a network (e.g., network **100**) that is available for delivering OTT video content **134** to the customer premise device. OTT content replacer **415** may determine a quality of the OTT video content to provide to the customer premise device based on indication **440**, device capability information **445**, and/or network bandwidth information **450**. OTT content replacer **415** may provide the OTT video content, with the determined quality, to the customer premise device. With CDN storage **105/110**, OTT content replacer **415** may be implemented by redirecting a customer premise device request to a different device with different characteristics.

In one example implementation, OTT content replacer **415** may adaptively add differentials (e.g., a type of linearity distortion which affects color saturation in television broadcasting) to OTT video content **134** to create higher quality OTT video content **455** (e.g., higher quality than OTT video content **134**, such as increasing from a 360i format to a 1080i format), and may replace OTT video content **134** with higher quality OTT video content **455**. As shown in FIG. **4**, OTT content replacer **415** may provide higher quality OTT video content **455** to the customer premise device (not shown). In one example, OTT content replacer **415** may monitor the quality added to OTT video content **134**, and may utilize the increase in quality for charging the customer associated with the customer premise device.

In other implementations, OTT content replacer **415** may adaptively subtract differentials from OTT video content **134** to create lower quality OTT video content **460** (e.g., lower quality than OTT video content **134**, such as decreasing from a 1080p format to a 480p format), and may replace OTT video content **134** with lower quality OTT video content **460**. As shown in FIG. **4**, OTT content replacer **415** may provide lower quality OTT video content **460** to the customer premise device (not shown). Alternatively, a version of higher and lower quality video content may be pre-computed and stored instead of doing transformations in response to each request. Such an approach may be more cost effective for popular content since storage is less expensive than processing.

Although FIG. **4** shows example functional components of SSSM servers **106/112**, in other implementations, SSSM servers **106/112** may include fewer functional components, different functional components, differently arranged functional components, or additional functional components than depicted in FIG. **4**. Alternatively, or additionally, one or more functional components of SSSM servers **106/112** may per-

form one or more other tasks described as being performed by one or more other functional components of SSSM servers **106/112**.

FIG. **5** is a diagram of example functional components of switched delivery system **118**. In one implementation, the functions described in connection with FIG. **5** may be performed by one or more components of device **200** (FIG. **2**). As shown in FIG. **5**, switched delivery system **118** may include multiple user components **505-1**, . . . , **505**-N (collectively referred to herein as "user components **505**," and singularly as "user component **505**") that include admit queues **510**, scheduling logic **515**, policing logic **520**, shaping logic **525**, and marking logic **530**; and may also include forwarding logic **535**.

User component **505** may include hardware or a combination of hardware and software that may receive different types of content (e.g., video content, voice content, data, etc.), and may schedule the different types of content for delivery to a corresponding subscriber (e.g., to a customer premise associated with a subscriber). For example, as shown in FIG. **5**, user components **505** may receive video content **320** (e.g., IPTV content), video content **330** (e.g., VOD content), non-real time video content **340** from CDN storage **105/110**, voice content (e.g., VoIP content), Internet content (e.g., data), etc.

Admit queues **510** may include hardware or a combination of hardware and software that may receive and store the different types of content in a particular order. In one implementation, admit queues **510** may be used to prioritize the different types of content (e.g., low priority, high priority, etc.) so that the different types of content may be scheduled for delivery to a corresponding subscriber.

Scheduling logic **515** may include hardware or a combination of hardware and software that may receive the different types of content (e.g., as prioritized by admit queues **510**), and may schedule the content for delivery to a corresponding subscriber.

Policing logic **520** may include hardware or a combination of hardware and software that may provide network security features (e.g., filtering, firewall capability, etc.) for the different types of content.

Shaping logic **525** may include hardware or a combination of hardware and software that may receive the different types of content and may apply traffic shaping to the content. For example, shaping logic **525** may apply traffic shaping to the content in order to optimize or guarantee performance of the content, improve latency, and/or increase usable bandwidth (e.g., by delaying content that meets certain criteria).

Marking logic **530** may include hardware or a combination of hardware and software that may apply traffic marking to the different types of content. Marking the different types of content may enable attributes for the content (e.g., belonging to a specific class or category) to be set or modified.

Forwarding logic **535** may include hardware or a combination of hardware and software that may receive a particular one of the different types of content, and may provide multicast replication for the particular content.

As further shown in FIG. **5**, the voice content may be provided to first admit queues **510** (e.g., the first from the top), and the first admit queues **510** may forward the voice content to scheduling logic **515**. Video content **330** (e.g., VOD content) may be provided to second admit queues **510** (e.g., the second from the top), and the second admit queues **510** may provide video content **330** to a first shaping logic **525**. Video content **320** (e.g., IPTV content) may be provided to forwarding logic **535**, and forwarding logic **535** may provide video content **320** to third admit queues **510** (e.g., the third from the top). The higher quality VOD and IPTV queues may be used by SSSM server **106/112** if SSSM server **106/112** is in the same policy control domain (e.g., the same service provider). Alternatively, if switched delivery system **118** is in another service provider domain (e.g., than SSSM server **106/112**), then other mechanisms for enabling higher quality for a set of IP packets, such as a differentiated service (Diffserv) or resource reservation protocol (RSVP) could be used. The third admit queues **510** may provide video content **320** to the first shaping logic **525**. The Internet content may be provided to fourth admit queues **510** (e.g., the fourth from the top), and the fourth admit queues **510** may provide the Internet content to a second shaping logic **535** (e.g., for traffic shaping). The second shaping logic **535** may provide the shaped Internet content to the first shaping logic **535**. CDN storage **105/110** may provide video content **340** (e.g., non-real time video content) to policing logic **520** (e.g., for filtering), and policing logic **520** may provide the filtered video content **340** to fifth admit queues **510** (e.g., the fifth from the top). The fifth admit queues **510** may provide the filtered video content **340** to marking logic **530** (e.g., for traffic marking), and marking logic **530** may provide the filtered/marked video content **340** to scheduling logic **515**.

The first shaping logic **525** may receive video content **320/330** and the Internet content, and may apply traffic shaping to video content **320/330** and the Internet content. The first shaping logic **525** may provide the shaped video content **320/330** and Internet content to scheduling logic **515**. Each scheduling logic **515** (e.g., of user components **505**) may receive video content **320-340**, the voice content, and the Internet content, and may schedule the content for ultimate delivery to BHR **126**, as indicated by reference number **540**. Each scheduling logic **515** may provide scheduled content **540** to another scheduling logic **515** (e.g., of switched delivery system **118**), and the other scheduling logic **515** may further schedule content **540** for delivery to BHR **126**, as indicated by reference number **545**. The other scheduling logic **515** may forward scheduled content **545** to BHR **126** (e.g., pursuant to a schedule determined by the other scheduling logic **515**). BHR **126** may forward scheduled content **545** (e.g., pursuant to the schedule) to one or more devices provided at customer premise **122** (e.g., STB **124**, HMD **128**, user device **132**, etc.). The net effect of the aforementioned queuing and scheduling logic may be to enable a bandwidth scavenger type of service (also called a lower effort service) that defers transmission in the event of any other traffic of higher priority.

As further shown in FIG. **5**, BHR **126** may include a congestion detector **550** that may receive scheduled content **545** from the other scheduling logic **515**, and may generate congestion feedback information **555** based on scheduled content **545**. Congestion feedback information **555** may include information associated with usage (e.g., congested, low traffic, medium traffic, etc.) of network **100**. Congestion detector **550** may provide congestion feedback information **555** to SSSM servers **106/112**, CDN storage **105/110**, and/or HMD **128**. In one example implementation, congestion feedback information **555** may be used by SSSM servers **106/112**, CDN storage **105/110**, and/or HMD **128** to determine when, how much, etc. non-real time video content may be delivered in network **100**.

In one implementation, SSSM servers **106/112** may receive congestion feedback information **555**, may determine a quality of non-real time video content **340** to provide based on congestion feedback **555**. In one example, if SSSM servers **106/112** detect network congestion (e.g., based on congestion feedback information **555**), SSSM servers **106/112** may replace non-real time video content **340** with lower quality

non-real time video content **340**. In another example, if SSSM servers **106/112** do not detect network congestion (e.g., based on congestion feedback information **555**), SSSM servers **106/112** may replace non-real time video content **340** with higher quality non-real time video content **340**.

Congestion detector **550** may implement a variety of congestion control methods (e.g., to generate congestion feedback information **555**), such as an explicit congestion notification (ECN) method, a pre-congestion notification (PCN) method, a re-inserted feedback ECN (re-ECN) method, a low extra delay background transport (ledbat) method, etc.

In the ECN method, the ECN may be negotiated between network endpoints (e.g., switched delivery system **118** and BHR **126**), and an ECN-aware device may set an IP header bit in a packet (e.g., instead of dropping the packet) to signal the beginning of congestion in a network (e.g., network **100**). A packet receiver may echo the congestion indication to a packet sender, and the packet sender may react as if the packet was dropped.

In the PCN method, PCN threshold rates may be configured on edge and backbone links in a trusted domain, and a network device (e.g., BHR **126**) may compare actual packet rates to the PCN threshold rates, and may mark packets that exceed the PCN threshold rates. A destination network device (e.g., BHR **126**) may return congestion feedback (e.g., congestion feedback information **555**) to a source network device. The source network device may police traffic based on flow rate, may determine whether new PCN flows can be admitted, may terminate existing PCN flows (e.g., in case of extreme congestion), etc. The re-ECN method may function similar to the PCN method, but in a non-trusted domain rather than in a trusted domain. In the ledbat method, ECN measurements or application layer latency measurements may be used to provide congestion feedback to "bandwidth scavenger" applications.

Although FIG. **5** shows example functional components of switched delivery system **118**, in other implementations, switched delivery system **118** may include fewer functional components, different functional components, differently arranged functional components, or additional functional components than depicted in FIG. **5**. Alternatively, or additionally, one or more functional components of switched delivery system **118** may perform one or more other tasks described as being performed by one or more other functional components of switched delivery system **118**.

FIGS. **6-8** are flow charts of an example process **600** for providing adaptive video quality substitution according to implementations described herein. In one implementation, process **600** may be performed by SSSM server **106** and/or SSSM server **112**. In another implementation, some or all of process **600** may be performed by another device or group of devices, including or excluding SSSM server **106** and/or SSSM server **112**.

As illustrated in FIG. **6**, process **600** may include intercepting OTT video content or a request (for OTT video content) prior to delivery of the OTT video content to a customer premise device of a network (block **610**), and determining copyright information associated with the requested OTT video content (block **620**). For example, in implementations described above in connection with FIG. **4**, OTT content intercept component **400** of SSSM servers **106/112** may intercept OTT video content **134** (e.g., provided to SHE **102** or VHO **108**) or OTT video content request **420** (e.g., provided to SHE **102** or VHO **108**). If OTT video content request **420** is received, OTT content intercept component **400** may also intercept the OTT video content requested by OTT video content request **420**. Rights determiner **405** of SSSM servers **106/112** may receive OTT video content **134** and/or request **420** from OTT content intercept component **400**, and may determine rights associated with OTT video content **134** or the OTT video content requested by OTT video content request **420**, as indicated by reference number **425**. In one example implementation, OTT video content **134** may include copyright information (e.g., reproduction rights or download rights as set forth by the DECE consortium) that may be interpreted by rights determiner **405**.

As further shown in FIG. **6**, process **600** may include receiving subscription and/or authentication information of a customer associated with the customer premise device (block **630**), receiving OTT video content provider information (block **640**), and validating the requested OTT video content based on the copyright information, the subscription/authentication information, and/or the OTT video content provider information (block **650**). For example, in implementations described above in connection with FIG. **4**, OTT content validator **410** of SSSM servers **106/112** may receive rights information **425** from rights determiner **405**, and may receive subscription/authentication information **430** and/or OTT content provider information **435** (e.g., from one or more other components of network **100**). Subscription/authentication information **430** may include subscription information of a customer associated with a customer premise device requesting OTT video content **134**, authentication information associated with the customer, etc. OTT content provider information **435** may include information (e.g., a name, price charged for content, etc.) associated with a provider of OTT video content **134**. OTT content validator **410** may validate OTT video content **134** based on rights information **425**, subscription/authentication information **430** and/or OTT content provider information **435**, and (e.g., if OTT video content **134** is valid) may provide an indication **440** that OTT video content **134** is valid to OTT content replacer **415**, which may be implemented by SSSM server **106/112** controlling CDN storage **105/110**.

Returning to FIG. **6**, process **600** may include receiving customer premise device capability information and network bandwidth information (block **660**), determining a quality of OTT video content to provide based on the customer premise device capability information and/or the network bandwidth information (block **670**), and providing OTT video content, with the determined quality, to the customer premise device (block **680**). For example, in implementations described above in connection with FIG. **4**, OTT content replacer **415** of SSSM servers **106/112** may receive indication **440** from OTT content validator **410**, and may receive device capability information **445** and/or network bandwidth information **450**. Device capability information **445** may include a capability (e.g., capable of receiving high quality video content, lower quality video content, etc.) of the customer premise device requesting OTT video content **134**. Network bandwidth information **450** may include bandwidth of a network (e.g., network **100**) that is available for delivering OTT video content **134** to the customer premise device. OTT content replacer **415** may determine a quality of the OTT video content to provide to the customer premise device based on indication **440**, device capability information **445**, and/or network bandwidth information **450**. OTT content replacer **415** may provide the OTT video content, with the determined quality, to the customer premise device.

Process block **670** may include the process blocks depicted in FIG. **7**. As shown in FIG. **7**, process block **670** may include adaptively adding differentials to the requested OTT video content to create higher quality OTT video content (block **700**), and replacing the requested OTT video content with the

higher quality OTT video content (block **710**). For example, in implementations described above in connection with FIG. **4**, OTT content replacer **415** may adaptively add differentials to OTT video content **134** to create higher quality OTT video content **455** (e.g., higher quality than OTT video content **134**, such as increasing from a 360i format to a 1080i format), and may replace OTT video content **134** with higher quality OTT video content **455**. Alternatively, instead of dynamically modifying OTT video content **134**, a pre-computed and stored version of higher quality OTT video content **455** may be retrieved.

Alternatively, process block **670** may include adaptively subtracting differentials from the requested OTT video content to create lower quality OTT video content (block **720**), and replacing the requested OTT video content with the lower quality OTT video content (block **730**). For example, in implementations described above in connection with FIG. **4**, OTT content replacer **415** may adaptively subtract differentials from OTT video content **134** to create lower quality OTT video content **460** (e.g., lower quality than OTT video content **134**, such as decreasing from a 1080p format to a 480p format), and may replace OTT video content **134** with lower quality OTT video content **460**. Alternatively, instead of dynamically modifying OTT video content **134**, a pre-computed and stored version of lower quality OTT video content **460** may be retrieved.

Process block **680** may include the process blocks depicted in FIG. **8**. As shown in FIG. **8**, process block **680** may include providing, to the customer premise device, higher quality OTT video content than the requested OTT video content (block **800**), and utilizing the increase in quality of the OTT video content for charging the customer (block **810**). Alternatively, process block **680** may include providing, to the customer premise device, lower quality OTT video content than the requested OTT video content (block **820**). For example, in implementations described above in connection with FIG. **4**, OTT content replacer **415** may provide higher quality OTT video content **455** to the customer premise device. In one example, OTT content replacer **415** may monitor the quality added to OTT video content **134**, and may utilize the increase in quality for charging the customer associated with the customer premise device. Alternatively, OTT content replacer **415** may provide lower quality OTT video content **460** to the customer premise device.

Systems and/or methods described herein may provide adaptive video quality substitution for video content. The adaptive video quality substitution may match a quality of the delivered video content to the capabilities of a device receiving the video content and/or based on network bandwidth available for delivering the video content. In one example, the systems and/or methods may apply adaptive video quality substitution to OTT video content. In other examples, the systems and/or methods may apply adaptive video quality substitution to video content other than OTT video content.

The foregoing description of implementations provides illustration and description, but is not intended to be exhaustive or to limit the invention to the precise form disclosed. Modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention.

For example, while series of blocks have been described with regard to FIGS. **6-8**, the order of the blocks may be modified in other implementations. Further, non-dependent blocks may be performed in parallel. .

It will be apparent that example aspects, as described above, may be implemented in many different forms of software, firmware, and hardware in the implementations illustrated in the figures. The actual software code or specialized control hardware used to implement these aspects should not be construed as limiting. Thus, the operation and behavior of the aspects were described without reference to the specific software code—it being understood that software and control hardware could be designed to implement the aspects based on the description herein.

Further, certain portions of the invention may be implemented as a "component" or "logic" that performs one or more functions. These components or logic may include hardware, such as a processor, an ASIC, or a FPGA, or a combination of hardware and software.

Even though particular combinations of features are recited in the claims and/or disclosed in the specification, these combinations are not intended to limit the disclosure of the invention. In fact, many of these features may be combined in ways not specifically recited in the claims and/or disclosed in the specification. Although each dependent claim listed below may directly depend on only one other claim, the disclosure of the invention includes each dependent claim in combination with every other claim in the claim set.

No element, act, or instruction used in the present application should be construed as critical or essential to the invention unless explicitly described as such. Also, as used herein, the article "a" is intended to include one or more items. Where only one item is intended, the term "one" or similar language is used. Further, the phrase "based on" is intended to mean "based, at least in part, on" unless explicitly stated otherwise.

What is claimed is:

1. A method implemented by a computing device in a network that delivers video content, the method comprising:

intercepting, by the computing device, requested video content prior to delivery of the requested video content to a customer premise device of the network;

receiving, by the computing device, subscription and authentication information of a customer associated with the customer premise device;

receiving, by the computing device, video content provider information;

validating, by the computing device, the requested video content based on the subscription and authentication information and based on the video content provider information;

receiving, by the computing device, capability information associated with the customer premise device;

receiving, by the computing device, bandwidth information associated with the network;

determining, by the computing device, whether to dynamically adjust a quality of video content to provide to the customer premise device, based on the customer premise device capability information and based on the network bandwidth information,

wherein, in response to determining to dynamically adjust the quality of the video content, the quality of the video content is dynamically adjusted based on differentials that correspond to a particular quality, and

wherein the differentials used to produce the dynamically adjusted quality of the video content further correspond to a higher or a lower video content quality; and

providing, by the computing device and to the customer premise device, the video content with the dynamically adjusted quality.

2. The method of claim **1**, where the computing device is provided in one or more of:

a super head end (SHE) of the network, or

a video hub office (VHO) of the network.

3. The method of claim 1, further comprising:
determining copyright information associated with the requested video content; and
validating the requested video content based on one or more of:
the copyright information,
the subscription and authentication information, or
the video content provider information.

4. The method of claim 3, where the copyright information includes reproduction rights, as set forth by the Digital Entertainment Content Ecosystem (DECE) consortium, associated with the requested video content.

5. The method of claim 1, where the video content includes over the top (OTT) video content.

6. The method of claim 1, where the subscription and authentication information includes one or more of:
a subscription of the customer for video content, or
information used to authenticate the customer for receipt of the requested video content.

7. The method of claim 1, where the video content provider information includes a price charged for the requested video content by a provider of the requested video content.

8. The method of claim 1, where the customer premise device capability information includes a level of quality of video content capable of being received by the customer premise device.

9. The method of claim 1, where the network bandwidth information includes bandwidth of the network that is available for delivering the requested video content to the customer premise device.

10. The method of claim 1, wherein determining whether to dynamically adjust the quality of video content includes:
adding differentials to the requested video content to create higher quality video content than the requested video content; and
replacing the requested video content with the higher quality video content.

11. The method of claim 1, wherein determining whether to dynamically adjust the quality of video content includes:
subtracting differentials from the requested video content to create lower quality video content than the requested video content; and
replacing the requested video content with the lower quality video content.

12. The method of claim 1, where providing video content with the determined quality includes:
providing, to the customer premise device, higher quality video content than the requested video content; and
utilizing the increase in quality of the requested video content for charging the customer.

13. The method of claim 1, where providing video content with the determined quality includes:
providing, to the customer premise device, lower quality video content than the requested video content.

14. A computing device provided in a network that delivers video content, where the computing device comprises:
a memory to store a plurality of instructions; and
a processor to execute instructions in the memory to:
intercept requested over the top (OTT) video content prior to delivery of the requested OTT video content to a customer premise device of the network,
receive subscription and authentication information of a customer associated with the customer premise device,
receive OTT video content provider information,
validate the requested OTT video content based on the subscription and authentication information and based on the OTT video content provider information,
receive capability information associated with the customer premise device,
receive bandwidth information associated with the network,
determine a quality of OTT video content or an adjusted quality of the OTT video content, to provide to the customer premise device, based on the customer premise device capability information and based on the network bandwidth information,
wherein the adjusted quality corresponds to an increase or a decrease of video content quality that is based on differentials that correspond to a particular quality of OTT video content, and
provide, to the customer premise device, OTT video content with the determined quality or the adjusted quality.

15. The computing device of claim 14, where the computing device is provided in one or more of:
a super head end (SHE) of the network, or
a video hub office (VHO) of the network.

16. The computing device of claim 14, where the processor is further to execute instructions in the memory to:
determine copyright information associated with the requested OTT video content, and
validate the requested OTT video content based on one or more of:
the copyright information,
the subscription and authentication information, or
the OTT video content provider information.

17. The computing device of claim 16, where the copyright information includes reproduction rights, as set forth by the Digital Entertainment Content Ecosystem (DECE) consortium, associated with the requested OTT video content.

18. The computing device of claim 14, where the subscription and authentication information includes one or more of:
a subscription of the customer for OTT video content, or
information used to authenticate the customer for receipt of the requested OTT video content.

19. The computing device of claim 14, where the OTT video content provider information includes a price charged for the requested OTT video content by a provider of the requested OTT video content.

20. The computing device of claim 14, where the customer premise device capability information includes a level of quality of OTT video content capable of being received by the customer premise device.

21. The computing device of claim 14, where the network bandwidth information includes bandwidth of the network that is available for delivering the requested OTT video content to the customer premise device.

22. The computing device of claim 14, where, when determining a quality of OTT video content, the processor is further to execute instructions in the memory to:
add differentials to the requested OTT video content to create higher quality OTT video content than the requested OTT video content, and
replace the requested OTT video content with the higher quality OTT video content.

23. The computing device of claim 14, where, when determining a quality of OTT video content, the processor is further to execute instructions in the memory to:
subtract differentials from the requested OTT video content to create lower quality OTT video content than the requested OTT video content, and

replace the requested OTT video content with the lower quality OTT video content.

24. The computing device of claim **14**, where, when providing OTT video content with the determined quality, the processor is further to execute instructions in the memory to one of:

provide, to the customer premise device, higher quality OTT video content than the requested OTT video content, or

provide, to the customer premise device, lower quality OTT video content than the requested OTT video content.

25. A system, comprising:

a non-transitory storage device for storing data; and

one or more devices, wherein at least one of the one or more devices includes a processor configured to:

intercept requested video content prior to delivery of the requested video content to a customer premise device of a network,

receive subscription and authentication information of a customer associated with the customer premise device,

receive video content provider information,

determine copyright information associated with the requested video content,

validate the requested video content based on one or more of the copyright information, the subscription and authentication information, or the video content provider information,

receive capability information associated with the customer premise device,

receive bandwidth information associated with the network,

determine whether a quality of video content is to be adjusted, to provide to the customer premise device, based on:

the customer premise device capability information,

the network bandwidth information, and

differentials that correspond to a particular quality, and

provide, to the customer premise device, video content with the determined quality.

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